MODELING AND FABRICATION OF INTAKE VALVE FOR PERODUA KANCIL ENGINE

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ABSTRACT

This project tell about how to produce intake valve for Perodua Kancil engine. Objective for this project is to modeling and fabricating intake valve. The material that use is aluminium. Idea to fabricate this intake valve come after have many new model and shape in market. In that case, the information about how to produce the intake valve easy to get in internet. Three dimensional drawing for this intake valve is using Solidwork software, COSMOS Flow software to analysis about flow movement and produce by CNC Lathe Machine. In market, this intake valve is made by casting proses and finalize by turning (lathe) process. But, for this project, the intake valve is fully produce by CNC Lathe Process (turning process)

ABSTRAK

Projek ini menerangkan tentang penghasilan komponen iaitu injap masuk bagi enjin Perodua Kancil. Objektif projek ini ialah mereka dan menghasilkan injap masuk. Injap masuk ini dihasilkan menggunakan aluminium. Idea pembuatan injap masuk ini terhasil setelah terdapat banyak model dan bentuk terkini di dalam pasaran. Hal ini menyebabkan sedikit maklumat cara pembuatannya mudah didapati di internet. Stuktur 3 dimensi injap masuk ini dihasilkan menggunakan perisian lukisan Solidwork, analisis melalui perisian COSMOS Flow dan seterusnya ditiru menggunakan CNC Lathe Machine. Injap masuk dihasilkan melalui proses tuangan dan diakhiri dengan proses pembubutan (putaran). Tetapi dalam projek ini, injap masuk dihasilkan sepenuhnya melalui proses pembubutan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Final year project is one of the subjects for this semester. In this subject, a project needs to do to fulfill the subject requirement. This project involves modeling and fabrication of intake valve for perodua kancil engine.

1.2 Problem Statements

In industry, valve normally produced by casting process. In this project, the valve is made by CAM method using CNC Lathe Machine.

1.3 Project Objectives

This project should be finished until the defect can be minimized. This project is apply the lesson and knowledgeable that we learn before. Then, we can practice the skill and solving the problem using academic study. This project also, to enhance a student skill and ability to work individually and work as a team. It also gives us, an experience and knowledge. So the objectives of this project are to fabricate intake valve for 660cc Perodua Kancil engine.

1.4 Project Scope

Basically, this project is base on these scopes of work:

a) 3D CAD modeling of the original production intake valve
b) 3D CAD modeling of the modified intake valve
c) Simulate flow around the valve using COSMOS flow
d) Machining of the original and modified intake valve using CAM Method

1.5 Project Organization

Chapter 2: Literature review. This chapter show about basic components in valve train, the main function of each component, valve clearance and other type of valve.

Chapter 3: Methodology. First, the intake valve is measured by vernier caliper and draw in Solid Works Software. The modified valve must be drawing basic on original production valve. Then simulate the drawings using Cosmos Flow Software. After that, CNC code (G-codes) must be created before transfer to machine.

Chapter 4: Result discussion. The result is get from CFD simulation like cut plot, flow trajectories, graph pressure versus curve length and velocity versus curve length.

Chapter 5: Conclusion. Valve can be fabricate using machining process (CNC lathe machining) and simulate flow inside the cylinder can be done using Cosmos Flow Software (CFD).

Table 1.1: Project planning

Activities	Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Title														
Verify main supervisor														
Verify project title														
Verify objectives & scope of project														
Literature review														
Valve train components														
Operating principle														
Get article from sciencedirect.com														
Methodology														
Measuring intake valve														
Engineering drawing														
CFD simulation														
Fabrication														
Result & discussion														
Conclusion														
Final presentation & complete report														

CHAPTER 2

LITERATURE STUDY

2.1 Introduction

This chapter contains about internal combustion engine, 4-stroke principle, companion cylinder, valve train and CNC Lathe machine. There are 7 basic components in valve train like valve, spring, rocker arm, lifters, camshaft, timing belt and crankshaft. Each engine cylinders have at least two valves, an intake valve and exhaust valve. The intake valves open just before the intake stroke begins. These allow the air-fuel mixture to enter the cylinder. The exhausts open just before the exhaust stroke begins so the burn gases can escape from the cylinder. 4 stroke cycle requires two 360° revolutions (720°) of the crankshaft. At the same times, the intake and exhaust valve each open once. Valves are opened by the camshaft. The camshaft and crankshaft are connected by timing belt or chain. There are half as many teeth on the crank drive on the cam drive.

2.2 Internal Combustion Engine

An engine is a machine that converts heat energy into mechanical energy. The heat from burning a fuel produces power which moves the vehicle. Sometimes the engine is called the power plant. Automotive engines are internal-combustion (IC) engines because the fuel that runs them is burned internally, or inside the engines. There are 2 types [1];

a. *Reciprocating engine* (Figure 2.1) – means moving up and down or back and forth. Most automotive engines are reciprocating. They have pistons that move up and down or reciprocate, in cylinders. These are piston engines

b. *Rotary engine* (Figure 2.2) – have rotors that spin or rotate. The only such engine now used in automobiles is the Wankle engine

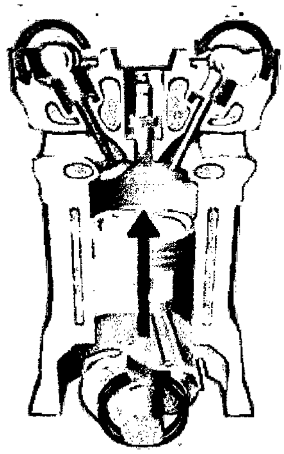


Figure 2.1: Reciprocating engine

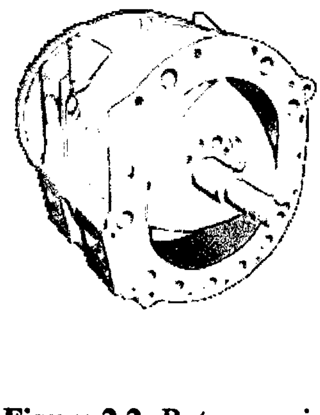


Figure 2.2: Rotary engine

2.3 4-Strokes Engine

A stroke is the movement of the piston from TDC (top dead center) to BDC (bottom dead center). They are 4 strokes in one 4 strokes cycle of the engine. They are called the intake stroke, compression stroke, power stroke and exhaust stroke [2].

i. *Intake stroke* – petrol will not burn unless it is mixed with the correct amount of air. It is very explosive when one part is mixed with about 15 parts of air. As the crankshaft turns, it pulls the rod and piston down in the cylinder. This action creates a suction known as engine vacuum, which draws in a mixture of air and fuel through the open intake valve. About 10,000 gallons of air is drawn in for every 1 gallon of fuel. The air and fuel mixture is supplied by the carburetor or by the fuel injection system. The ideal mixture (called stoichiometric) for the combined purpose of engine performance, emission control and fuel economy is about 14:7:1 [2].

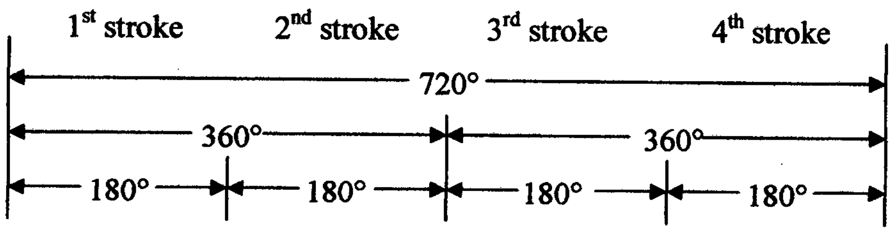
ii. *Compression stroke* - a puddle of petrol that is lit on fire in open air does not produce power. If it is confined in a cylinder, usable power can be produced. Compressing the mixture of air and fuel into a smaller area makes it easier to burn. The compression stroke begins at BDC after the intake stroke is complete. The intake valve closes and the piston moves up in the cylinder, compressing the air and fuel mixture. As the piston moves toward TDC, the mixture is compressed to about 1/8 of the volume is occupied when the piston was at BDC. In this case, the compression ratio is said to be 8:1. If the mixture is compressed to 1/12 its original volume, the compression ratio is then 12:1 [2].

iii. *Power stroke* – as the piston approaches TDC on its compression stroke, the compressed air and fuel mixture becomes very explosive. When the ignition system generates a spark at the spark plug, the fuel ignites. As the fuel mixture burns, it expands, forcing the piston to move down in the cylinder until it reaches BDC. The action of the piston turns the crankshaft to power car. The power stroke is sometimes called the expansion strokes [2].

iv. *Exhaust stroke* – as the piston near BDC on the power stroke another valve open, allowing the spent gases to escape. Because the burning gases are still expanding, they are force out trough the open exhaust valve. As the crank continues to turn past BDC, the piston moves up in the cylinder, helping to force the remaining exhaust gases out trough the open exhaust valve. A few degrees after the piston passes TDC, the exhaust valve closed. The entire 4 stroke cycle repeats itself [2].

2.4 Companion cylinders

Any engine with an even number of cylinders will have pairs of cylinder called companion cylinders, or running mates. The pistons go up and down in pairs. When one piston is starting its power strokes, its companion piston is at the start of its intake stroke. To find out which cylinder are companions, take the first half of the engine's firing order and place it above the second half [2].



1st cylinder	Power	Exhaust	Intake	Compression
2nd cylinder	Compression	Power	Exhaust	Intake
3rd cylinder	Intake	Compression	Power	Exhaust
4th cylinder	Exhaust	Intake	Compression	Power

Figure 2.3: Companion cylinders

Figure 1.31 it appears that the same carburetor for a single cylinder engine could theoretically be use to operate a four cylinder engine that had cylinders of nearly the same displacement. It appears that the 4 stroke engine only uses the carburetor during the intake stroke. But the engine actually breathes air and fuel for a period of time longer than the intake stroke's 180° of crankshaft rotation. The valves start to open before TDC and closes after BDC when crankshaft has traveled considerably into the compression stroke. The reason for this is to allow the cylinder to fill with as much air and fuel mixture as possible. A single carburetor on this engine would have to be larger so it could serve more than one cylinder at a time because of the overlapping intake strokes.

2.5 Valve

Each engine cylinder has at least 2 valves, an intake valve and exhaust valve. The intake valves open just before the intake stroke begins. These allow the air-fuel mixture to enter the cylinder. The exhaust valve opens just before the exhaust stroke begins so the burned gases can escape from the cylinder. The intake valve is usually larger than the exhaust. The reason is that when the intake valve is open, the only force moving air-fuel mixture into the cylinder is atmospheric pressure. When the exhaust valve opens on the exhaust stroke, there is still high pressure in the engine cylinder. A smaller exhaust valve provides enough space for the high pressure exhaust gases to get out of the cylinder. Some valves have chrome-plated stems and a hard alloy tip welded onto the stem end. This reduces wear on these two areas. Other valves have a hollow stem to reduce valve weight. Lighter valves reduce the effects of inertia. These increase engine power and responsiveness [1].

2.5.1 Valve Arrangement

a) *L-Head Engines* – The L-head engine has the valves and the camshaft in cylinder block. This arrangement was once popular for automotive engine. Now, it is used only in small engine for lawn mowers and similar equipment. These are applications where light weight and simplicity are important. The L-head engine has two drawbacks for automotive use. First, it cannot be designed to have a high compression ratio. The higher compression ratio, the more power the engine produces. Second, the L-head engine has excessive exhaust emissions. The exhaust gas contains too much unburned and partly burned fuel. The reason is that the combustion chamber surface are large and relatively tool. This prevents combustion of the layers of air-fuel mixture close to those surfaces.

b) *Overhead-Valve Engine* – In an overhead valve or pushrod engine, the camshaft is in the cylinder block and the valves are in the cylinder head. Overhead-valve engine have higher compression ratios than L-head engines. Locating the valves directly over the piston permits the clearance volume to be smaller. This is the volume above the piston at TDC. When the air-fuel mixture is compressed into a smaller space, the compression ratio is higher. This means more engine torque and power. Some overhead-valve engines have *valve reliefs* cut into the piston heads. The valve reliefs provide space into which the valves can open without striking the piston.

c) *Overhead-Camshaft Engines (OHC)* – Many newer engine designs place the camshaft on the cylinder head. One reason for the shift to OHC engine is that pushrod and rocker arms have inertia. They resist changing speed and direction. Pushrod and rocker arm inertia effect valve action. They resist moving until sufficient force is applied to them. As a result, the rocker arm and pushrod bend or flex before they open the valve. With the camshaft on the cylinder head, the cams can act directly on the bucket tappets or rocker arms.

d) *Multi-Valve Engine* – Engine with more then two valves per cylinder are referred to as multivalve engine. The additional valves allow more air-fuel mixture to enter and the exhaust gas to escape more easily. This improves the volumetric efficiency of the engine. Also, the valve head diameter is smaller and the valves weight less. This reduces the effects of inertia and reduces the valve-spring force needed to closer a larger valve at high engine speed.

2.6 Valve Train

i. *Crankshaft* – Sometimes casually abbreviated to crank, is the part of an engine which translates reciprocating linear piston motion into rotation. It typically connects to a flywheel, to reduce the pulsation characteristic of the four-stroke cycle, and sometimes a torsional or vibrational damper at the opposite end, to reduce the torsion vibrations often caused along the length of the crankshaft by the cylinders farthest from the output end acting on the torsional elasticity of the metal [3].

ii. *Timing Belt* - A timing belt is a part of an internal combustion engine that controls the timing of the engine's valves. The term "timing belt" is also used for general case of any flat belt with integral teeth. Such belts are used for power transmission or to interchange rotary motion and linear motion. A common non-automotive application is in linear positioning systems. Such belts have also been used in efforts to make a cleaner, lower-maintenance bicycle transmission but have never become popular in this application. In the internal combustion engine application, the timing belt connects the crankshaft to the camshaft(s) which in turn controls the opening and closing of the engine's valves. A four-stroke engine requires that the valves open and close once every other turns of the crankshaft. The timing belt does this. It has custom teeth to turn the camshaft(s) synchronized with the crankshaft and is specifically designed for a particular